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APPLICATIONS OF FRICTION STIR WELDING AND ITS ADVANTAGES AND LIMITATIONS

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ABSTRACT

In this paper, the feasibility of Friction Stir Welding (FSW) of Aluminium alloy pipe with Stainless Steel plate is studied. Aluminium alloy and Stainless Steel are widely used in aerospace, automotive, marine, defense, construction etc. due to their high strength, low weight, high machinability, good conductivity of heat and electricity etc. Friction stir welding is preferred for joining these materials as it is a strong state produce welding procedure and issues related with welding of Aluminum amalgams and tempered steel can be stifled through this procedure. This welding procedure is a strong state welding method that uses a non-consumable turning device that is allowed to rub against the work piece consequently creating frictional welding. At the point when the weld requirements, for example, device or work piece turn speed, welding time, pivotal burden are ideal the contact between the work piece and the apparatus produces enough welding to make a plastic twisting layer at the weld interface. The procedure doesn't include any softening procedure and entire procedure happens in strong state through plastic disfigurement and mass stream among the work pieces. The trial examination of FSW is finished by shifting the erosion mix welding parameters, for example, work piece turn speed, welding time. The trial is finished utilizing Aluminum compound funnel of various widths, for example, Aluminum pipes with distances across 18.5 mm, 25 mm and 32 mm. The test is conducted and the outcomes are evaluated.

***KEYWORDS:** Applications, Friction Stir Welding, Advantages & Limitations*

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Original Article

INTRODUCTION

Friction welding s the welding process in which the heat required for welding is obtained by friction between the ends of the two parts to be joined. One of the parts to be joined is turned at a fast close around 3000 rpm and the other part is pivotally lined up with the subsequent one and squeezed firmly against it. The contact between the two sections raises the temperature of both the finishes. At that point, the revolution of the part is halted suddenly and the weight on the fixed part is expanded with the goal that the joining happens [1]. This is additionally called as Friction Welding. Erosion welding can be considered as a manufacture welding since the welding is completed with the utilization of weight. In rubbing welding, the welding required for the welding procedure is created because of the grinding between two surfaces to be joined. Enough welding can be produced and the temperature of the mating point can be raised to the level where the surfaces exposed to rubbing may get welded together. During Friction welding, various strong state forms happens utilizing the frictional welding created through the immediate cooperation between moving work pieces, with expansion of a swaging power to plastically diffuse material between the two work pieces. Numerous material blends can be joined and there are various activities in which this can be completed [2]. Grinding welding of littler parts can be done utilizing focus machine with suitable clasping and apparatuses and machining settings yet for greater parts uncommon machines must be utilized. This is because

of the way that the power accessibility in a machine may not be adequate for turning a greater part at the ideal speed and for giving adequate pivotal power required to Friction welding (The power necessity for erosion welding of greater parts may fluctuate between 25KVA to 200KVA). Another perspective is that the quick withdrawal and the mmediate braking of pivoting part would be outlandish when all is said in machines [4].

Types of Friction Welding

Straight Friction Welding is one sort of grating welding that is for the most part utilized for the airplane business as it enables the welder to weld various materials; it is utilized for fixing of apparatus parts and to construct best in class gas turbine parts that are hard to assemble utilizing customary welding techniques. Fundamentally, t includes non-liquefying plastic disfigurement procedure to deliver high honesty weld leaves behind lesser or no earlier surface readiness. This kind of Friction Welding is named straight grating welding as the relative movement between the work pieces is direct. It s utilized in joining turbine cutting edges to the rotor in the aeronautic trade. Presently, scientists are taking a shot at low-cost straight grating welding machines for car industry where it might be utilized for assembling brake plates, wheel edges cylinder heads and so forth [6]. In LFW process, the parts to be welded are compelled to come in direct contact of one another and afterward they are exposed to an upset movement. This results in frictional warming of work pieces at the weld plane and through this manner temperature raises close to its Melting point. Over the long haul, this thermo-plastic layer is expelled at the fringe of the weld-layer as undulated sheets of metal named as blaze [10]. The development of glimmer accommodates the way that any interfacial has been tossed out during the erosion between the parts. The welding influenced zone (HAZ) in LFW is little in light of the fact that the joining of parts happens at a quicker rate and the immediate welding contribution to the weld-pool is sufficiently only to make a little HAZ. So, with appropriate choice of material and weld parameters, the material disfigurement at the weld surface can be controlled [7].

The issues that lie with LFE are the tribology of the activity, heat stream in the weld pool and all the more explicitly the portrayal of the thermo-plastic material stream during relentless state LFW. It is a need that these realities must be efficiently tended to. So, a proper material expulsion model can be detailed precisely. This will guarantee in decrease of computational cost found in doing FEA of the procedures be kept inside worthy points of confinement [8].

Rotary Friction Welding (RFW)

In RFW, one work piece is rotated against the other. It is the most commonly used friction welding process in automobile ndustry. The process has been used to manufacture suspension rods, steering columns, gear box forks and drive shafts and engine valves, in which, there is requirement of welding of unlike materials of valve stem and head.

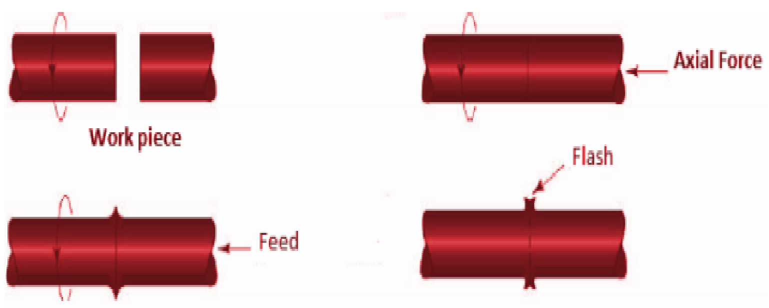

Figure 1: RFW Process.

ADVANTAGES AND LIMITATIONS OF FRICTION STIR WELDING

The solid-state nature of FSW leads to several advantages over fusion welding methods, as problems associated with cooling from the liquid phase are avoided. Issues, for example, porosity, solute redistribution, hardening breaking and liquation splitting don't emerge during FSW. When all is said in done, FSW has been found to deliver a low grouping of imperfections and is extremely tolerant to varieties in parameters and materials [12].

FSW is related with various nteresting deformities on the off chance that it isn't done appropriately. Lacking weld temperatures, because of low rotational paces or high navigate speeds, for nstance, mply that the weld material can't suit the broad misshapening during welding. This may bring about long, burrow like deformities running along the weld, which may happen superficially or subsurface. Low temperatures may likewise restrict the fashioning activity of the device thus lessen the congruity of the bond between the material from each side of the weld. The light contact between the material has offered ascend to the name "kissing bond". This mperfection is especially stressing, since it is hard to dentify utilizing non-destructive techniques, for example, X-beam or ultrasonic testing. On the off chance that the pin isn't sufficiently long or the device emerges from the plate, at that point the interface at the base of the weld may not be disturbed and manufactured by the device, bringing about an absence of-infiltration imperfection. This is basically a score in the material, which can be a potential wellspring of weakness splits.

Various potential preferences of FSW over customary combination welding forms have been dentified [15]:

- Good mechanical properties in the as-welded condition.
- Improved well-being because of the non-appearance of harmful exhaust or the scatter of liquid material.
- No consumables — A strung pin made of traditional device steel, e.g., solidified H13, can weld more than 1 km (0.62 mi) of aluminum, and no filler or gas shield is required for aluminum.
- Easily robotized on straightforward processing machines — lower arrangement costs and less preparing.
- Can work n all positions (even, vertical, and so on.), as there is no weld pool.
- Generally, great weld appearance and negligible thickness under/over-coordinating, in this way, diminishing the requirement for costly machining in the wake of welding.
- Can utilize more slender materials with same joint quality.
- Low ecological effect.
- General execution and money saving advantages from changing from combination to grating. In any case, a few impediments of the procedure have been distinguished:
- Exit opening left when device is pulled back.
- Large down powers required with substantial cinching mportant to hold the plates together.
- Less adaptable than manual and circular segment forms (troubles with thickness varieties and non-direct welds).
- Often more slowly navigate rate than some combination welding systems, despite the fact that this might be counter balanced, if less welding passes are required.

APPLICATIONS OF FRICTION STIR WELDING

The FSW process has initially been patented by TWI in most industrialised countries and licensed for over 183 users. Friction stir welding and its variants – friction stir spot welding and friction stir processing – are used for the following industrial applications: shipbuilding and offshore, aerospace, automotive, rolling stock for railways, general fabrication,[16-18] robotics, and computers.

Shipbuilding and off Shore

Friction stir welding was used to prefabricate the aluminium panels of the *Super Liner Ogasawara* at Mitsui Engineering and Shipbuilding.

Two Scandinavian aluminium extrusion companies were the first to apply FSW commercially to the manufacture of fish freezer panels at Sapa in 1996, just as deck boards and helicopter landing stages at Marine Aluminum Aanensen. Marine Aluminum Aanensen in this way converged with Hydro Aluminum Maritime to become Hydro Marine Aluminum. A portion of these cooler boards are presently created by Riftec and Bayards. In 1997, two-dimensional grinding mix welds in the hydrodynamically flared bow area of the body of the sea watcher vessel. The Boss were delivered at Research Foundation Institute with the primary versatile FSW machine. The Super Liner Ogasawara at Mitsui Engineering and Shipbuilding is the biggest contact mix welded transport up until now. The Sea Fighter of Nichols Bros and the Freedom-class Littoral Combat Ships contain pre-assembled boards by the FSW fabricators. Advanced Technology and Friction Stir Link, Inc. respectively.[19] The Houbei-class rocket vessel has grating mix welded rocket dispatch holders of China Friction Stir Center. HMNZS Rotoiti in New Zealand has FSW boards made by Donovans in a changed over processing machine.[20] Various organizations apply FSW to protective layer plating for land and/or water capable ambush ships.

Aviation

Longitudinal and circumferential erosion mix welds are utilized for the Falcon 9 rocket promoter tank at the SpaceX production line.

Joined Launch Alliance applies FSW to the Delta II, Delta IV, and Atlas V superfluous dispatch vehicles, and the first of these with an erosion mix welded interstage module was propelled in 1999. The procedure is additionally utilized for the Space Shuttle outer tank, for Ares I and for the Orion Crew Vehicle test article at NASA[needs update], just as Falcon 1 and Falcon 9 rockets at SpaceX. The toe nails for incline of Boeing C-17 Globemaster III payload air ship by Advanced Joining Technologies [21] and the load boundary bars for the Boeing 747 Large Cargo Freighter [7] were the primary industrially delivered airplane parts. FAA-endorsed wings and fuselage boards of the Eclipse 500 airplane were made at Eclipse Aviation, and this organization conveyed 259 rubbing mix welded business planes, before they were constrained into Chapter 7 liquidation. Floor boards for Airbus A400M military air ship are currently made by Pfalz Flugzeugwerke and Embraer utilized FSW for the Legacy 450 and 500 Jets [8]. Friction mix welding likewise is utilized for fuselage boards on the Airbus A380. BRÖTJE-Automation utilizes grinding mix welding for gantry creation machines produced for the aviation segment, just as other mechanical applications.[22]

Car

The middle passage of the Ford GT is produced using two aluminum expulsions erosion mix welded to a twisted aluminum sheet and houses the fuel tank.

Aluminum motor supports and suspension swaggers for extended Lincoln Town Car were the main car parts that were rubbing mix welded at Tower Automotive, which utilize the procedure additionally for the motor passage of the Ford GT. A side project of this organization is called Friction Stir Link, Inc. furthermore, effectively abuses the FSW procedure, for example for the flatbed trailer "Transformation" of Fontaine Trailers.[4] In Japan, FSW is applied to suspension swaggers at Showa Denko and for joining of aluminum sheets to electrifies steel sections for the boot (trunk) top of the Mazda MX-5. Rubbing mix spot welding is effectively utilized for the hat (hood) and back entryways of the Mazda RX-8 and the boot cover of the Toyota Prius. Wheels are grinding mix welded at Simmons Wheels, UT Alloy Works and Fundo. Rear seats for the Volvo V70 are grating mix welded at Sapa, HVAC cylinders at Halla Climate Control and fumes gas distribution coolers at Pierburg. Tailor welded blanks are erosion mix welded for the Audi R8 at Riftec.[23]. The B-segment of the Audi R8 Spider is grating mix welded from two expulsions at Hammerer Aluminum Industries in Austria.

Railways

The high-quality low-bending body of Hitachi's A-train British Rail Class 395 is contact mix welded from longitudinal aluminum expulsions.

Since 1997, rooftop boards were produced using aluminum expulsions at Hydro Marine Aluminum with a bespoke 25 m long FSW machine, for example for DSB class SA-SD trains of Alstom LHB.[9] Curved side and rooftop boards for the Victoria line trains of London Underground, side boards for Bombardier's Electrostar trains [10] at Sapa Group and side boards for Alstom's British Rail Class 390 Pendolino trains are made at Sapa Group. Japanese worker and express A-trains, [24] and British Rail Class 395 trains are grating mix welded by Hitachi, while Kawasaki applies erosion mix spot welding to rooftop boards and Sumitomo Light Metal produces Shinkansen floor boards. Imaginative FSW floor boards are made by Hammerer Aluminum Industries in Austria for the Stadler KISS twofold decker rail vehicles, to acquire an inward tallness of 2 m on the two stories and for the new vehicle collections of the Wuppertal Suspension Railway [25].

Welding sinks for cooling high-control gadgets of trains are made at Sykatek, EBG, Austerlitz Electronics, Euro Composite, Sapa and Rapid Technic, and are the most well-known utilization of FSW because of the brilliant welding move [26].

Manufacture

The tops of 50-mm-thick copper canisters for atomic waste are appended to the chamber by grating mix welding at SKB [27].

Figure 2

Friction Stir Processed Knives by MegaStir

Façade panels and cathode sheets are friction stir welded at AMAG and Hammerer Aluminium ndustries, including friction stir lap welds of copper to aluminium. Bizerba meat slicers, Ökolüfter HVAC units and Siemens X-ray vacuum vessels are friction stir welded at Riftec. Vacuum valves and vessels are made by FSW at Japanese and Swiss companies. FSW is also

used for the encapsulation of nuclear waste at SKB n 50-mm-thick copper canisters. Pressure vessels from ø1 m semispherical forgings of 38.1 mm thick aluminium alloy 2219 at Advanced Joining Technologies and Lawrence Livermore Nat Lab.[28] Friction stir processing is applied to ship propellers at Friction Stir Link, Inc. and to hunting knives by DiamondBlade. Bosch uses it in Worcester for the production of heat exchangers.

Robotics

KUKA Robot Group has adapted its KR500-3MT heavy-duty robot for friction stir welding via the DeltaN FS tool. The system made its first public appearance at the EuroBLECH show in November 2012 [29].

Personal Computers

Apple applied friction stir welding on the 2012 iMac to effectively join the bottom to the back of the device.[30]

CONCLUSIONS

Now-a-days extensive studied on Friction stir welding is being carried out as this welding method has shown many promises such as welding of unweldable metals, polymers etc. The parameters of friction welding are weld speed, rpm of the work piece or tool, feed (axial force), welding time etc. These have to be optimized for getting good quality friction welding. Though FSW is being applied to weld able materials at present, further study s needed to make it cost effective and to make it flexible so that every configuration can be welded with the help of FSW. The materials that are welded through FSW are aluminum and a wide variety of aluminum alloys, brass, bronze, metallic carbides, for example Tungsten (W) and Titanium (Ti) carbides, cobalt based alloys, columbium, copper, cupronickel alloys, lead, magnesium alloys, molybdenum, nickel alloys, mild steel, carbon steel, free-machining steel, maraging steel, stainless steel, tool steel, sintered steel, tantalum, titanium and titanium alloys, tungsten and zirconium etc.

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